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## (54) SOLID HIGHPOLYMER ELECTROLYTE TYPE FUEL CELL

(57)Abstract:

PURPOSE: To provide a solid highpolymer electrolyte type fuel cell equipped with a reaction gas humidifier in which the stable amount of humidification is obtained in accordance with a change in the amount of reaction gas, the miniaturization and the capacity increase of which is easy to make.

CONSTITUTION: The stack 10 of a solid highpolymer electrolyte type fuel cell is constituted by laminating plural layers unit cells 1 including a solid high polymer film 2, a fuel electrode 3 and an oxidant electrode 4 through a bipolar plate having reaction gas passages 6, 7 made of recessed grooves. Reaction gas humidifiers 11, 21, are provided, which are equipped with a vapor permeation film 12, a gas humidification chamber 13 defined by the film 12 and a chamber 14 for gas to be humidified, and which humidify reaction gas while off-gas exhausted from a reaction gas passage is used as humidification gas and

reaction gas supplied to the reaction gas passage is used as gas to be humidified.

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CLAIMS

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[Claim(s)]

[Claim 1] The single cel which consists of a solid-state poly membrane which has ion conductivity, and the fuel electrode and oxidizer electrode arranged by sticking to the both sides In the thing which comes to carry out two or more layer laminating through the bipolar plate which has the reactant gas path which

becomes the part which counters said fuel electrode of both sides of a gas impermeable plate, and each oxidizing agent electrode from a concave It has the steam transparency film, and the humidification gas chamber and the humidified gas chamber formed with this steam transparency film. The solid-state polyelectrolyte mold fuel cell characterized by coming to prepare the reactant gas humidification equipment which humidifies reactant gas by making into humidified gas the reactant gas which supplies the off-gas discharged from said reactant gas path to humidification gas and said reactant gas path.

[Claim 2] The solid-state polyelectrolyte mold fuel cell according to claim 1 characterized by forming and becoming so that the reaction air which the humidification gas chamber of reactant gas humidification equipment was open for free passage to the outlet side of an oxidizer path, introduced air pole off-gas, and the humidified gas chamber opened for free passage and humidified to the entrance side of an oxidizer path may be supplied to an oxidizer path.

[Claim 3] The solid-state polyelectrolyte mold fuel cell according to claim 1 characterized by forming and becoming so that the fuel gas which the humidification gas chamber of reactant gas humidification equipment was open for free passage to the outlet side of a fuel gas path, introduced fuel electrode off-gas, and the humidified gas chamber opened for free passage and humidified to the entrance side of a fuel gas path may be supplied to a fuel gas path.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the humidification structure of the solid-state polyelectrolyte mold fuel cell which used the solid-state poly membrane as an electrolyte membrane, and the reactant gas for humidifying a

solid-state poly membrane especially.

[0002]

[Description of the Prior Art] Drawing 2 is the sectional view in which, and showing it, and the single cel 1 consists of a solid-state poly membrane 2 which has ion conductivity, and the fuel electrode (anode electrode) 3 and the oxidizer electrode (cathode electrode) 4 supported so that it might stick to the both sides. [ the single cellular structure of a solid-state polyelectrolyte mold fuel cell ] [ **] [ type ] Moreover, the bipolar plate 5 which pinches the single cel 1 consists of a gas impermeable plate which has conductivity. By supplying the oxygen or reaction air as an oxidizer to the oxidizer path 7 formed in the fuel gas path 6 formed in the field side which touches the fuel electrode 3 as a concave as a concave in the hydrogen as fuel gas at the field side which touches the oxidizer electrode 4 The generation of electrical energy based on electrochemical reaction is performed by inter-electrode [ of the couple of the single cel 1 ]. In addition, the solid-state polyelectrolyte mold fuel cell of desired output voltage is obtained by carrying out two or more layer laminating of the single cel 1 and the bipolar plate 5 to less than [ 1V ], since the output voltage of the single cel 1 constituted in this way is low, and constituting a stack.

[0003] On the other hand as a solid-state poly membrane 1 which has ion conductivity For example, the thing using the par fluorocarbon sulfonic-acid film (the U.S., Du Pont, trade name Nafion) which is proton exchange film as an electrolyte membrane is known. They are 20 ohm-cm at ordinary temperature by having and carrying out the saturation water of the proton (hydrogen ion) exchange group into a molecule. While the following specific resistance is shown and functioning as a proton conductivity electrolyte, it functions also as a diaphragm which prevents mixing of fuel gas and oxidant gas. Namely, the anode reaction (H2 ->2H++2e-) which disassembles a hydrogen molecule into a hydrogen ion and an electron in an anode electrode (fuel electrode) side A cathode reaction is performed, respectively. in a cathode electrode (oxidizer electrode) side, water is generated from oxygen, a hydrogen ion, and an electron

-- electrochemical reaction (2H++1/2 O2+2e-->H2 O) -- Electrochemical reaction which 2 O2 ->H2 O [ H2+1/] Becomes as a whole is performed, and generated output is supplied to a load with the electron which moves toward a cathode in an external circuit from an anode.

[0004] As mentioned above, while maintaining the inside of the solid-state poly membrane 2 to a saturation moisture state in order to maintain highly the generation efficiency of a solid-state polyelectrolyte mold fuel cell since the film functions as proton exchange film when solid-state polyelectrolyte type ********** carries out the saturation water of the electrolyte membrane, it is 50-100-degreeC about the operating temperature of a solid-state polyelectrolyte mold fuel cell. It is necessary to hold to extent and to keep low the specific resistance of a solid-state poly membrane. For this reason, after the solid-state polyelectrolyte film 2 of each ** cel 1 has carried out the water of the water of a saturation content beforehand, assembly operation of a stack is performed. However, if it generates electricity by raising an operating temperature to the above-mentioned temperature requirement, the desiccation operation of the solid-state poly membrane 2 shown below occurs, the solid-state poly membrane 2 cannot be maintained to a saturation moisture state, but the problem that the generation efficiency of a solid-state polyelectrolyte mold fuel cell falls will occur. Namely, proton 2H+ generated in the anode reaction while the water generated by electrochemical reaction by fuel gas and oxidant gas was carried out out of the system In case the inside of a solid-state poly membrane is turned to a cathode from an anode and it moves, desiccation of a solid-state poly membrane advances by a child's water carrying out orientation several minutes, moving to a proton together, and being carried out out of a system with fuel gas and an oxidizer.

[0005] Then, in order to avoid such a situation, water is added to the reactant gas (fuel gas and oxidizer) supplied to the reactant gas paths 6 and 7, the steam concentration in reactant gas (steam partial pressure) is raised, and what was constituted so that evaporation of the moisture from the solid-state poly

membrane 2 might be suppressed is known. As the humidification approach of reactant gas, the humidifier which collected the molten baths heated more than the operating temperature of a fuel cell or it is formed in the exterior of a fuel cell, and the bubbling humidifying method which supplies the reactant gas which BABURINKU, humidified and humidified reactant gas in the warm water of this humidifier to each ** cel of a solid-state polyelectrolyte mold fuel cell is learned.

[0006]

[Problem(s) to be Solved by the Invention] In the humidification approach using an above-mentioned bubbling type humidifier Since it is necessary to adjust the amount of bubbling of the gas in a humidifier according to the amount of supply of reactant gas, while a solid-state polyelectrolyte mold fuel cell is enlarged and a humidifier is enlarged corresponding to the increase of the amount of bubbling, and this The problem that the control supplied without delay became difficult was in the fuel cell in the condition of having controlled the amount of bubbling corresponding to fluctuation of the load of a fuel cell, and having humidified enough.

[0007] Moreover, it needed to ask for the heat source for holding the water temperature of a humidifier more than an operating temperature and an EQC, and feed water outside, and there was also a problem that the thermal efficiency as a solid-state polyelectrolyte mold fuel cell fell. The object of this invention is to obtain the amount of humidification which was concerned with change of the amount of reactant gas, and was stabilized that there is nothing, and obtain the solid-state polyelectrolyte mold fuel cell equipped with the reactant gas humidification equipment in which a miniaturization and large-capacity-izing are possible.

[0008]

[Means for Solving the Problem] The solid-state poly membrane which has ion conductivity according to this invention in order to solve the above-mentioned technical problem, The single cel which consists of the fuel electrode and oxidizer electrode which were arranged by sticking to the both sides In the solid-

state polyelectrolyte mold fuel cell which comes to carry out two or more layer laminating through the bipolar plate which has the reactant gas path which becomes the part which counters said fuel electrode of both sides of a gas impermeable plate, and each oxidizing agent electrode from a concave It has the steam transparency film, and the humidification gas chamber and the humidified gas chamber formed with this steam transparency film. It shall come to prepare the reactant gas humidification equipment which humidifies reactant gas by making into humidified gas the reactant gas which supplies the off-gas discharged from said reactant gas path to humidification gas and said reactant gas path.

[0009] Moreover, the humidification gas chamber of reactant gas humidification equipment shall be open for free passage to the outlet side of an oxidizer path, and air pole off-gas shall be introduced, and it shall form and become so that the reaction air which the humidified gas chamber opened for free passage and humidified to the entrance side of an oxidizer path may be supplied to an oxidizer path. Furthermore, the humidification gas chamber of reactant gas humidification equipment shall be open for free passage to the outlet side of a fuel gas path, and fuel electrode off-gas shall be introduced, and it shall form and become so that the fuel gas which the humidified gas chamber opened for free passage and humidified to the entrance side of a fuel gas path may be supplied to a fuel gas path.

[0010]

[Function] In the configuration of this invention, it has the steam transparency film, and the humidification gas chamber and the humidified gas chamber formed with this steam transparency film. By having constituted so that the reactant gas humidification equipment which humidifies reactant gas by making into humidified gas the reactant gas which supplies the off-gas discharged from a reactant gas path to humidification gas and a reactant gas path might be formed The off-gas with which the steam partial pressure rose by generation-of-electrical-energy generation water's serving as a steam, and joining reactant gas

in a reactant gas path is made into humidification gas. While the closed circuit of the generation-of-electrical-energy generation water which humidifies non-humidified reactant gas with the steam which penetrated the steam transparency film using the difference of the steam partial pressure to non-humidified reactant gas, and is supplied to a fuel cell as humidification reactant gas is obtained Since the closed circuit of the generation-of-electrical-energy heat of formation which collects the heat energy of the off-gas with which generation of heat of a fuel cell was taken, and temperature rose to the reactant gas of ordinary temperature through the steam transparency film can be formed The generation water and heat of formation which a solid-state polyelectrolyte mold fuel cell discharges are recycled in reactant gas, and humidification and the function heated beforehand are obtained in reactant gas, without needing an external heat source.

[0011] Moreover, since the amount of reactant gas and the amount of off-gas which are supplied to a fuel cell always have proportionality and generation-of-electrical-energy generation water and heat of formation are also proportional to the amount of supply of reactant gas, the function to perform humidification and the preheating of reactant gas without delay, without needing special control is obtained. Furthermore, since the surface area of the steam transparency film can be easily extended corresponding to the amount of reactant gas, without enlarging reactant gas humidification equipment by folding up and arranging the steam transparency film for example, to a wave type, the function which easy-izes miniaturization of reactant gas humidification equipment and large capacity-ization is obtained.

[0012] The function to prevent desiccation of the solid-state polyelectrolyte film more certainly is obtained further again by forming reactant gas humidification equipment in any a fuel gas and oxidant gas side, and preparing both sides.

[0013]

[Example] Hereafter, this invention is explained based on an example. Drawing 1 is system configuration drawing in which, and showing it, and omits the duplicate explanation by giving the same reference mark to the same component as the

conventional technique. [ the solid-state polyelectrolyte mold fuel cell which becomes the example of this invention ] [ **] [ type ] In drawing, both the oxidizer humidification equipment 11 and fuel gas humidification equipment 21 as reactant gas humidification equipment are equipped with the steam transparency film 12 which forms the inside of the tight container in the humidification gas chamber 13 and the humidified gas chamber 14. For example, the Asahi Glass Co., Ltd. make and trade name SUNSEP-W are used for the steam transparency film 12. In addition, if it constitutes so that it may set in a tight container where the steam transparency film 12 is folded up in the shape of bellows, or it may form mutually using the steam transparency film of two or more sheets, respectively in two or more parallel humidification gas chambers 13 and humidified gas chambers 14, the advantage which can extend the surface area of the steam transparency film 12 corresponding to the maximum amount of supply of reactant gas, without enlarging a tight container will be acquired.

[0014] Moreover, a fuel gas humidification system is constituted by connecting with the fuel gas path 6 by the side of the fuel electrode 3 of the solid-state polyelectrolyte mold fuel cell 10 the bomb 15 which stores the hydrogen as fuel gas through the humidified gas chamber 14 of a regulator valve 16 and fuel gas humidification equipment 21, and constituting so that the fuel electrode off-gas discharged from the outlet side may be emitted out of a system through the humidification gas chamber 13 and a relief valve 16. Moreover, the humidification system of an oxidizer is constituted by connecting with the oxidizer path 7 by the side of the oxidizer electrode 4 of the solid-state polyelectrolyte mold fuel cell 10 the reaction air as an oxidizer supplied by the reaction air blower 18 through the humidified gas chamber 14 of oxidizer humidification equipment 11, and constituting so that the air pole off-gas discharged from the outlet side may be emitted out of a system through the humidification gas chamber 13 and a relief valve 19.

[0015] Since the generation-of-electrical-energy generation water which generated oxidizer humidification equipment 11 with the oxidizer electrode 4 for

example, in the oxidizer path 7 of a fuel cell 10 serves as a steam and it joins reaction air in the solid-state polyelectrolyte mold fuel cell constituted as mentioned above, the steam partial pressure of the air pole off-gas discharged from the oxidizer path 7 rises, and the difference of a steam partial pressure occurs between the reaction air which carries out counterflow contact through the steam transparency film 12. Moreover, the heat energy of the air pole off-gas with which generation of heat of a fuel cell was taken, and temperature rose more than the operating temperature of a fuel cell is transmitted to the reaction air of ordinary temperature through the steam transparency film 12, and the temperature of reaction air rises even near the operating temperature. Consequently, the steam which penetrated the steam transparency film 12 using the difference of a steam partial pressure can supply the reaction air near the operating temperature which will humidify the reaction air which is not humidified [ which it preheated near the operating temperature ], and was humidified by the saturation state to the oxidizer electrode 4 through the oxidizer path 7 of a solid-state polyelectrolyte mold fuel cell, and can prevent desiccation of an electrode. Thus, according to oxidizer humidification equipment 11, the generation-of-electrical-energy generation water and heat of formation of a solid-state polyelectrolyte mold fuel cell can be recycled in an ordinary temperature and reaction non-humidified air side, and humidification and the preheating of reaction air can be performed simultaneously.

[0016] Moreover, since the amount of reactant gas and the amount of off-gas which are supplied to a fuel cell are always in proportionality and generation-of-electrical-energy generation water and heat of formation are also proportional to the amount of supply of reactant gas, it is carried out without delay, without needing humidification of reactant gas, and control with a special preheating, and the advantage which can supply the reactant gas humidified corresponding to fluctuation of a load to a solid-state polyelectrolyte mold fuel cell is acquired.

[0017] Furthermore, since the surface area of the steam transparency film can be easily extended corresponding to the amount of reaction GASUGA, without

enlarging reactant gas humidification equipment by folding up and arranging the steam transparency film for example, to a wave type, the advantage which can carry out [ easy ]-izing of the miniaturization of reactant gas humidification equipment and the large-capacity-izing is acquired. In addition, although the function obtained also about fuel gas humidification equipment 21 is the same as that of it of oxidizer humidification equipment 11, the oxidizer path 7 side has many burst sizes of generation-of-electrical-energy generation water, and a bubbling type humidifier etc. is formed auxiliary, and since it is few to a fuel gas path side, when the amounts of humidification of the fuel gas by fuel gas humidification equipment 21 run short, it may be constituted so that lack of the amount of humidification may be compensated.

[0018]

[Effect of the Invention] This invention was equipped with the steam transparency film, and the humidification gas chamber and the humidified gas chamber formed with this steam transparency film as mentioned above, and it constituted it so that the reactant gas humidification equipment which humidifies reactant gas by making into humidified gas the reactant gas which supplies the off-gas discharged from a reactant gas path to humidification gas and a reactant gas path might be formed. Consequently, while recycling the generation-of-electrical-energy generation water and heat of formation of a solid-state polyelectrolyte mold fuel cell in an ordinary temperature and non-humidified reactant gas side through the steam transparency film and being able to perform humidification and the preheating of reactant gas simultaneously The amount of reactant gas and the amount of off-gas which are supplied to a fuel cell are always in proportionality. Since the surface area of the steam transparency film can be easily extended corresponding to the amount of reactant gas, without being able to perform humidification and the preheating of reactant gas without delay corresponding to fluctuation of a load, without needing special control, and enlarging reactant gas humidification equipment The trouble in the conventional humidification approach using a bubbling type humidifier is eliminated. the **

which does not need makeup of an external heat source or water -- large-capacity-izing and a miniaturization -- easy steam humidification equipment can be used, the reactant gas which corresponded to fluctuation of a load without delay, and humidified and preheated can be supplied to a fuel cell, and the solid-state polyelectrolyte mold fuel cell which can prevent desiccation of the solid-state polyelectrolyte film can be offered.

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] System configuration drawing in which, and showing it [ the solid-state polyelectrolyte mold fuel cell which becomes the example of this invention ] [ **] [ type ]

[Drawing 2] The sectional view in which, and showing it [ the single cellular structure of a solid-state polyelectrolyte mold fuel cell ] [ **] [ type ]

[Description of Notations]

1 Single Cel of Solid-state Polyelectrolyte Mold Fuel Cell

2 Solid-state Polyelectrolyte Film

3 Fuel Electrode

4 Oxidizer Electrode

5 Bipolar Plate

6 Fuel Gas Path

7 Oxidizer Path

10 Solid-state Polyelectrolyte Mold Fuel Cell (Stack)

11 Reactant Gas Humidification Equipment (Oxidizer Humidification Equipment)

12 Solid-state Polyelectrolyte Film

13 Humidification Gas Chamber

14 Humidified Gas Chamber

15 Hydrogen Bomb

18 Reaction Air Blower

21 Reactant Gas Humidification Equipment (Fuel Gas Humidification Equipment)

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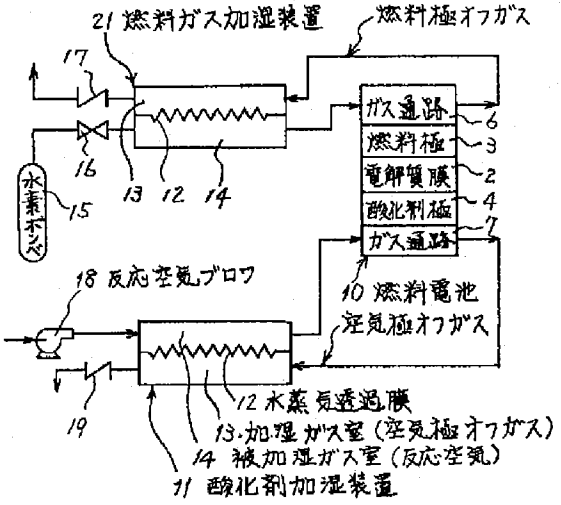
(54)【発明の名称】　固体高分子電解質型燃料電池

(57)【要約】

【目的】反応ガス量の変化に応じて安定した加湿量が得られ、小型化，大容量化が容易な反応ガス加湿装置を備えた固体高分子電解質型燃料電池を得る。

【構成】イオン導電性を有する固体高分子膜２および燃料電極３，酸化剤電極４を有する単セル１を、凹溝からなる反応ガス通路６，７を有するバイポーラプレートを介して複数層積層してなる固体高分子電解質型燃料電池スタック１０において、水蒸気透過膜１２と、この水蒸気透過膜により画成された加湿ガス室１３および被加湿ガス室１４とを備え、反応ガス通路から排出されるオフガスを加湿ガス，反応ガス通路に供給する反応ガスを被加湿ガスとして反応ガスを加湿する反応ガス加湿装置１１，２１を設ける。



【特許請求の範囲】

【請求項１】イオン導電性を有する固体高分子膜と、その両面に密着して配された燃料電極および酸化剤電極とからなる単セルを、ガス不透過性板の両面の前記燃料電極および酸化剤電極それぞれに対向する部分に凹溝からなる反応ガス通路を有するバイポーラプレートを介して複数層積層してなるものにおいて、水蒸気透過膜と、この水蒸気透過膜により画成された加湿ガス室および被加湿ガス室とを備え、前記反応ガス通路から排出されるオフガスを加湿ガス，前記反応ガス通路に供給する反応ガスを被加湿ガスとして反応ガスを加湿する反応ガス加湿装置を設けてなることを特徴とする固体高分子電解質型燃料電池。

【請求項２】反応ガス加湿装置の加湿ガス室が酸化剤通路の出口側に連通して空気極オフガスを導入し、被加湿ガス室が酸化剤通路の入口側に連通して加湿した反応空気を酸化剤通路に供給するよう形成してなることを特徴とする請求項１記載の固体高分子電解質型燃料電池。

【請求項３】反応ガス加湿装置の加湿ガス室が燃料ガス通路の出口側に連通して燃料極オフガスを導入し、被加湿ガス室が燃料ガス通路の入口側に連通して加湿した燃料ガスを燃料ガス通路に供給するよう形成してなることを特徴とする請求項１記載の固体高分子電解質型燃料電池。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、固体高分子膜を電解質膜として用いた固体高分子電解質型燃料電池、ことに固体高分子膜を加湿するための反応ガスの加湿構造に関する。

【０００２】

【従来の技術】図２は固体高分子電解質型燃料電池の単セル構造を模式化して示す断面図であり、単セル１は、イオン導電性を有する固体高分子膜２と、その両面に密着するよう支持された燃料電極（アノード電極）３および酸化剤電極（カソード電極）４とで構成される。また、単セル１を挟持するバイポーラプレート５は導電性を有するガス不透過性板からなり、その燃料電極３に接する面側に凹溝として形成された燃料ガス通路６に燃料ガスとしての水素を、酸化剤電極４に接する面側に凹溝として形成された酸化剤通路７に酸化剤としての酸素または反応空気を供給することにより、単セル１の一対の電極間で電気化学反応に基づく発電が行われる。なお、このように構成された単セル１の出力電圧は１Ｖ以下と低いので、単セル１とバイポーラプレート５を複数層積層してスタックを構成することにより、所望の出力電圧の固体高分子電解質型燃料電池が得られる。

【０００３】一方、イオン導電性を有する固体高分子膜１としては、例えばプロトン交換膜であるパーフロロカーボンスルホン酸膜（米国，デュポン社，商品名ナフィオン）を電解質膜として用いたものが知られており、分子中にプロトン（水素イオン）交換基を持ち、飽和含水することにより常温で２０Ω-cm 以下の比抵抗を示し、プロトン導電性電解質として機能するとともに、燃料ガスと酸化剤ガスの混合を防ぐ隔膜としても機能する。すなわち、アノード電極（燃料電極）側では水素分子を水素イオンと電子に分解するアノード反応（$H_2 \rightarrow 2H^+ + 2e^-$）が、カソード電極（酸化剤電極）側では酸素と水素イオンと電子から水を生成する電気化学反応（$2H^+ + 1/2\ O_2 + 2e^- \rightarrow H_2O$）なるカソード反応がそれぞれ行われ、全体として$H_2 + 1/2\ O_2 \rightarrow H_2O$なる電気化学反応が行われ、アノードからカソードに向かって外部回路を移動する電子により発電電力が負荷に供給される。

【０００４】上述のように、固体高分子電解質型燃料電池ては、電解質膜を飽和含水させることにより、膜はプロトン交換膜として機能するものであるから、固体高分子電解質型燃料電池の発電効率を高く維持するためには固体高分子膜２中を飽和含水状態に維持するとともに、固体高分子電解質型燃料電池の運転温度を５０～１００°Ｃ程度に保持して固体高分子膜の比抵抗を低く保つ必要がある。このため、各単セル１の固体高分子電解質膜２はあらかじめ飽和量の水を含水させた状態でスタックの組立作業が行われる。ところが、運転温度を上記温度範囲に高めて発電を行うと、下記に示す固体高分子膜２の乾燥作用が発生し、固体高分子膜２を飽和含水状態に維持できず固体高分子電解質型燃料電池の発電効率が低下するという問題が発生する。すなわち、燃料ガスおよび酸化剤ガスにより電気化学反応で生成した水が系外に持ち出されるとともに、アノード反応において生成したプロトン$2H^+$が固体高分子膜中をアノードからカソードに向けて移動する際、プロトンに数分子の水が配向して一緒に移動し、燃料ガス，酸化剤とともに系外に持ち出されることにより、固体高分子膜の乾燥が進行する。

【０００５】そこで、このような事態を回避するために、反応ガス通路６および７に供給する反応ガス（燃料ガスおよび酸化剤）に水を添加して反応ガス中の水蒸気濃度（水蒸気分圧）を高め、固体高分子膜２からの水分の蒸発を抑えるよう構成したものが知られている。反応ガスの加湿方法としては、燃料電池の外部に燃料電池の運転温度あるいはそれ以上に加熱した湯を溜めた加湿器を設け、この加湿器の温湯の中に反応ガスをバブリンクして加湿し、加湿した反応ガスを固体高分子電解質型燃料電池の各単セルに供給するバブリング加湿法が知られている。

【０００６】

【発明が解決しようとする課題】上述のバブリング式加湿器を用いる加湿方法においては、反応ガスの供給量に応じて加湿器におけるガスのバブリング量を調節する必要があるため、固体高分子電解質型燃料電池が大型化す

るとともにバブリング量が増し、これに対応して加湿器が大型化するとともに、燃料電池の負荷の変動に対応してバブリング量を制御し、かつ充分加湿した状態で燃料電池に遅滞なく供給する制御が困難になるという問題があった。

【0007】また、加湿器の水温を運転温度と同等以上に保持するための熱源および給水を外部に求める必要があり、固体高分子電解質型燃料電池としての熱効率が低下するという問題もあった。この発明の目的は、反応ガス量の変化に関わりなく安定した加湿量が得られ、小型化，大容量化が可能な反応ガス加湿装置を備えた固体高分子電解質型燃料電池を得ることにある。

【0008】

【課題を解決するための手段】上記課題を解決するために、この発明によれば、イオン導電性を有する固体高分子膜と、その両面に密着して配された燃料電極および酸化剤電極とからなる単セルを、ガス不透過性板の両面の前記燃料電極および酸化剤電極それぞれに対向する部分に凹溝からなる反応ガス通路を有するバイポーラプレートを介して複数層積層してなる固体高分子電解質型燃料電池において、水蒸気透過膜と、この水蒸気透過膜により画成された加湿ガス室および被加湿ガス室とを備え、前記反応ガス通路から排出されるオフガスを加湿ガス，前記反応ガス通路に供給する反応ガスを被加湿ガスとして反応ガスを加湿する反応ガス加湿装置を設けてなるものとする。

【0009】また、反応ガス加湿装置の加湿ガス室が酸化剤通路の出口側に連通して空気極オフガスを導入し、被加湿ガス室が酸化剤通路の入口側に連通して加湿した反応空気を酸化剤通路に供給するよう形成してなるものとする。さらに、反応ガス加湿装置の加湿ガス室が燃料ガス通路の出口側に連通して燃料極オフガスを導入し、被加湿ガス室が燃料ガス通路の入口側に連通して加湿した燃料ガスを燃料ガス通路に供給するよう形成してなるものとする。

【0010】

【作用】この発明の構成において、水蒸気透過膜と、この水蒸気透過膜により画成された加湿ガス室および被加湿ガス室とを備え、反応ガス通路から排出されるオフガスを加湿ガス，反応ガス通路に供給する反応ガスを被加湿ガスとして反応ガスを加湿する反応ガス加湿装置を設けるよう構成したことにより、反応ガス通路内で反応ガスに発電生成水が水蒸気となって加わることにより水蒸気分圧が上昇したオフガスを加湿ガスとし、未加湿の反応ガスに対する水蒸気分圧の差を利用して水蒸気透過膜を透過した水蒸気により未加湿の反応ガスを加湿し、加湿反応ガスとして燃料電池に供給する発電生成水の閉回路が得られるとともに、燃料電池の発熱を奪って温度が上昇したオフガスの熱エネルギーを水蒸気透過膜を介して常温の反応ガスに回収する発電生成熱の閉回路を形成できるので、固体高分子電解質型燃料電池が排出する生成水および生成熱を反応ガスにリサイクルし、外部熱源を必要とせずに反応ガスを加湿，予熱する機能が得られる。

【0011】また、燃料電池に供給する反応ガス量とオフガス量とは常に比例関係があり、かつ発電生成水および生成熱も反応ガスの供給量に比例するので、反応ガスの加湿および予熱を特別の制御を必要とせずに遅滞なく行う機能が得られる。さらに、水蒸気透過膜を例えば波型に折り畳んで配置することにより、反応ガス加湿装置を大型化することなく水蒸気透過膜の表面積を反応ガス量に対応して容易に拡張できるので、反応ガス加湿装置の小型化，大容量化を容易化する機能が得られる。

【0012】さらにまた、反応ガス加湿装置は燃料ガス側，酸化剤ガス側いずれに設けてもよく、また双方に設けることにより、固体高分子電解質膜の乾燥をより確実に防止する機能が得られる。

【0013】

【実施例】以下、この発明を実施例に基づいて説明する。図１はこの発明の実施例になる固体高分子電解質型燃料電池を模式化して示すシステム構成図であり、従来技術と同じ構成部分には同一参照符号を付すことにより、重複した説明を省略する。図において、反応ガス加湿装置としての酸化剤加湿装置１１および燃料ガス加湿装置２１は、ともにその気密容器内を加湿ガス室１３と被加湿ガス室１４とに画成する水蒸気透過膜１２を備える。水蒸気透過膜１２には、例えば旭硝子社製，商品名SUNSEP-Wが用いられる。なお、水蒸気透過膜１２を蛇腹状に折り畳んだ状態で気密容器内セットするか、あるいは複数枚の水蒸気透過膜を用い、互いに並列な複数の加湿ガス室１３および被加湿ガス室１４にそれぞれ画成するよう構成すれば、水蒸気透過膜１２の表面積を気密容器を大型化せずに反応ガスの最大供給量に対応して拡張できる利点が得られる。

【0014】また、燃料ガスとしての水素を貯蔵するボンベ１５を調整弁１６および燃料ガス加湿装置２１の被加湿ガス室１４を介して固体高分子電解質型燃料電池１０の燃料電極３側の燃料ガス通路６に連結し、その出口側から排出される燃料極オフガスを加湿ガス室１３およびリリーフ弁１６を介して系外に放出するよう構成することにより、燃料ガス加湿系が構成される。また、反応空気ブロワ１８により供給される酸化剤としての反応空気を酸化剤加湿装置１１の被加湿ガス室１４を介して固体高分子電解質型燃料電池１０の酸化剤電極４側の酸化剤通路７に連結し、その出口側から排出される空気極オフガスを加湿ガス室１３およびリリーフ弁１９を介して系外に放出するよう構成することにより、酸化剤の加湿系が構成される。

【0015】上述のように構成された固体高分子電解質型燃料電池において酸化剤加湿装置１１は、例えば燃料

電池１０の酸化剤通路７内で酸化剤電極４で生成した発電生成水が水蒸気となって反応空気に加わるので、酸化剤通路７から排出される空気極オフガスの水蒸気分圧が上昇し、水蒸気透過膜１２を介して向流接触する反応空気との間に水蒸気分圧の差が発生する。また、燃料電池の発熱を奪って燃料電池の運転温度以上に温度が上昇した空気極オフガスの熱エネルギーは水蒸気透過膜１２を介して常温の反応空気に伝達され、反応空気の温度が運転温度近くにまで上昇する。その結果、水蒸気分圧の差を利用して水蒸気透過膜１２を透過した水蒸気が運転温度近くに予熱された未加湿の反応空気を加湿することになり、飽和状態に加湿された運転温度に近い反応空気を固体高分子電解質型燃料電池の酸化剤通路７を介して酸化剤電極４に供給し、電極の乾燥を防止することができる。このように、酸化剤加湿装置１１によれば、固体高分子電解質型燃料電池の発電生成水および生成熱を常温，未加湿の反応空気側にリサイクルして反応空気の加湿および予熱を同時に行うことができる。

【００１６】また、燃料電池に供給する反応ガス量とオフガス量とは常に比例関係にあり、かつ発電生成水および生成熱も反応ガスの供給量に比例するので、反応ガスの加湿および予熱が特別の制御を必要とせずに遅滞なく行われ、負荷の変動に対応して加湿された反応ガスを固体高分子電解質型燃料電池に供給できる利点が得られる。

【００１７】さらに、水蒸気透過膜を例えば波型に折り畳んで配置することにより、反応ガス加湿装置を大型化することなく水蒸気透過膜の表面積を反応ガスガ量に対応して容易に拡張できるので、反応ガス加湿装置の小型化，大容量化を容易化できる利点が得られる。なお、燃料ガス加湿装置２１についても得られる機能は酸化剤加湿装置１１のそれと同様であるが、発電生成水の放出量が酸化剤通路７側に多く、燃料ガス通路側に少ないため、燃料ガス加湿装置２１による燃料ガスの加湿量が不足する場合には、バブリング式加湿器などを補助的に設け、加湿量の不足を補うよう構成されてよい。

【００１８】

【発明の効果】この発明は前述のように、水蒸気透過膜と、この水蒸気透過膜により画成された加湿ガス室および被加湿ガス室とを備え、反応ガス通路から排出されるオフガスを加湿ガス，反応ガス通路に供給する反応ガスを被加湿ガスとして反応ガスを加湿する反応ガス加湿装置を設けるよう構成した。その結果、固体高分子電解質型燃料電池の発電生成水および生成熱を水蒸気透過膜を介して常温，未加湿の反応ガス側にリサイクルし、反応ガスの加湿および予熱を同時に行えるとともに、燃料電池に供給する反応ガス量とオフガス量とは常に比例関係にあり、負荷の変動に対応して反応ガスの加湿および予熱を特別の制御を必要とせずに遅滞なく行え、かつ反応ガス加湿装置を大型化することなく水蒸気透過膜の表面積を反応ガス量に対応して容易に拡張できるので、バブリング式加湿器を用いた従来の加湿方法での問題点が排除され、外部熱源や水の補給を必要とせずに大容量化，小型化容易な水蒸気加湿装置を用い、負荷の変動に遅滞なく対応して加湿かつ予熱した反応ガスを燃料電池に供給し、固体高分子電解質膜の乾燥を防止できる固体高分子電解質型燃料電池を提供することができる。

【図面の簡単な説明】

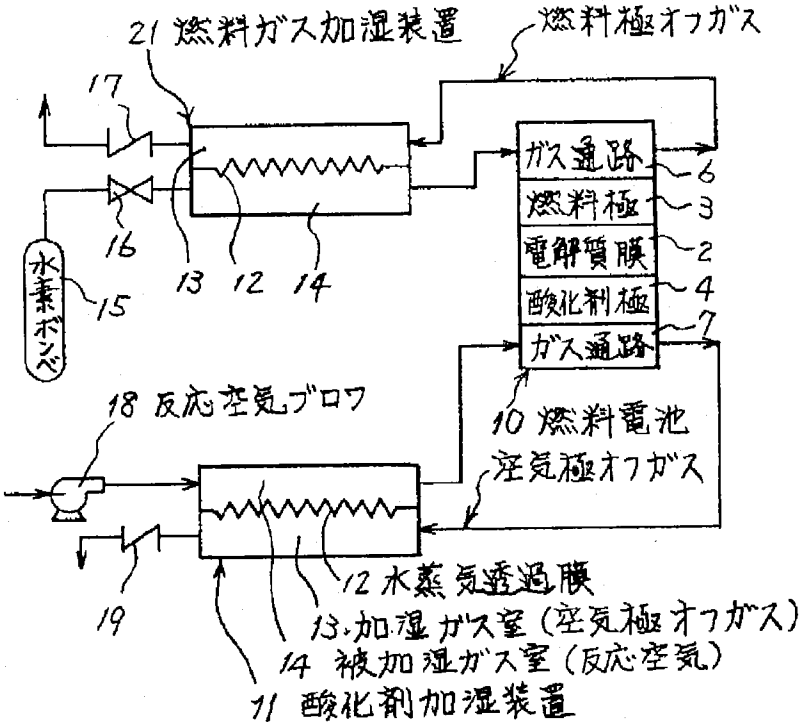
【図１】この発明の実施例になる固体高分子電解質型燃料電池を模式化して示すシステム構成図

【図２】固体高分子電解質型燃料電池の単セル構造を模式化して示す断面図

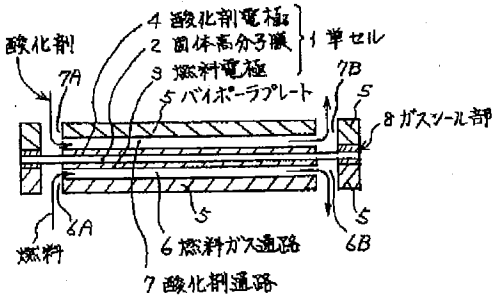
【符号の説明】

１　固体高分子電解質型燃料電池の単セル
２　固体高分子電解質膜
３　燃料電極
４　酸化剤電極
５　バイポーラプレート
６　燃料ガス通路
７　酸化剤通路
１０　固体高分子電解質型燃料電池（スタック）
１１　反応ガス加湿装置（酸化剤加湿装置）
１２　固体高分子電解質膜
１３　加湿ガス室
１４　被加湿ガス室
１５　水素ボンベ
１８　反応空気ブロワ
２１　反応ガス加湿装置（燃料ガス加湿装置）

【図1】


21 燃料ガス加湿装置
燃料極オフガス
17
ガス通路
燃料極
電解質膜
酸化剤極
ガス通路
6
3
2
4
7
16
13
12
14
水素ボンベ
15
18 反応空気ブロワ
10 燃料電池
空気極オフガス
12 水蒸気透過膜
19
13 加湿ガス室（空気極オフガス）
14 被加湿ガス室（反応空気）
11 酸化剤加湿装置

【図2】


酸化剤
4 酸化剤電極
2 固体高分子膜
1 単セル
3 燃料電極
5 バイポーラプレート
7A
7B
5
8 ガスシール部
6A
燃料
6 燃料ガス通路
6B
7 酸化剤通路